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ILLUMINATED SIGN OR PANEL ARRANGEMENT

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The present invention relates to an illuminated sign or panel arrangement, e.g., for traffic information, advertising, other information, decoration etc.

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A number of illuminated sign or panel arrangements are previously known, such as that discussed in, for example, British Patent No. 459683 where fluorescent tubes are embedded between sheets of transparent, translucent or opaque material. British Patent Application No. 2165344 discloses a glow-discharge cold-cathode tube that is embedded in a slab of transparent plastics material.

Furthermore, published British Patent Application GB 2281142-A discloses a display arrangement where lighting tubes are embedded in an opaque layer of plastic and where the light is caused to pass out through a glass sheet via a transparent plastic layer. Moreover, Norwegian Patent 164198 discloses a light panel having light channels, where a light source is made in the form of at least one light channel in the light panel plate.

None of the known arrangements referred to above provide light distribution across the light plate surface that is close to uniform.

European Patent Specification 495273-A1 relates to a light panel where light rays are sent in from one end edge of the panel and where transverse grooves which form a saw tooth pattern in the plate are provided. To prevent an attenuation of the light diffusion and light intensity along the length of the plate, the thickness of the plate must vary, being thickest at the light input end. French Patent Specification 2732494 relates to a plate of transparent material where light is supplied to the plate from one end thereof by means of fibre optics which receive light from a common light source.

A similar solution is found in French Patent Specification 2679363 where light fibres can be placed in grooves in a plate.

European Patent Specification 520368-A2 relates to a fibre optic, back-illuminated panel having additional background lighting in relation to the amount of light that is sent therethrough in devices such as rubber keys, diaphragm switches, LCDs or the like. The fibre-optic panel includes a light source and a layer of optical fibres that are arranged adjacent to one another and which transmit the light therein to different points

throughout the arrangement to provide increased uniform light intensity at particular points or evenly distributed light throughout the arrangement. The optical fibres are selectively terminated at different points by forming holes through the layer of optical fibres using a laser, according to a predetermined geometrical pattern of scattered point stored in a computer memory. In one particular embodiment for use with LCDs, a foam layer is used to disperse light in order to provide uniform illumination.
However, a major problem with the known arrangements is to be able to make them of uniform thickness whilst allowing the diffusion of light to be as uniform as possible.

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Therefore the arrangement mentioned in the introduction is characterised, according to the invention, by at least one clear light distribution plate of a transparent plastics material, e.g., acrylic, or glass, where one side of the plate is provided with a plurality of substantially parallel grooves, and where the grooves extend wholly or partly along the length of the plate between a first and a second end thereof, at least one elongate light source device extending transverse to the parallel grooves, and a light diffuser plate or display film disposed adjacent to the other side of the light distribution plate and/or a light reflector plate or sheet placed adjacent to the first side of the light distribution plate.

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Additional embodiments of the arrangement will be apparent from the attached patent claims and from the description below with reference to the attached drawings.

Fig. 1 shows a first embodiment of the arrangement according to the application.

Fig. 2 shows a second embodiment of the arrangement according to the application.

Fig. 3 shows a third embodiment of the arrangement according to the application.

Fig. 4 shows a modification of the light distribution plate according to the invention.

Fig. 5 indicates the typical positioning of a light source device or devices in relation to the direction of the grooves in the plate.

Fig. 6 is a cross-sectional view taken along the line VI-VI in Fig. 5.

Figs. 7 and 8 are more detailed cross-sectional views of the embodiment of Fig. 3.

Fig. 9 shows a fourth embodiment of the arrangement.

Fig. 10 is a cross-sectional view of the arrangement shown in Fig. 2.

Fig. 11 shows a minor modification of the arrangement in Figs. 2 and 10.

Fig. 12 illustrates the position of grooves in the light distribution plate and the diffusion of light from the grooves.

Figs. 13-18 show typical light distribution patterns for different embodiments of the arrangement.

Fig. 19 shows, in a slightly exaggerated manner, a modification of a groove in the light distribution plate.

Fig. 20 is another modification of a groove in the light distribution plate.

Fig. 21 shows yet another modification of a groove in the light distribution plate.

Fig. 22 shows the principle of light input into the light distribution plate using light-emitting diodes.

Fig. 23 shows the input of light into the light distribution plate using optical fibres.

The embodiments illustrated in the drawings and discussed in the following description should be viewed as typical examples of possible designs of the arrangement according to the invention, and should not be regarded as defining the limits of the variations that are possible.

Fig. 1 shows the structure of a sign or a panel for the purpose of providing maximum uniform illumination of a text or the like that is to be displayed, wherein the text or the like may be placed on an outer plate 1 of glass or plastic that is coloured throughout or translucent. Light sources in the form of luminous tubes 2, 3, e.g., cold cathode tubes are placed in semi-circular recesses 4, 5 and 6, 7 respectively in a respective plate 8, 9 of transparent material, for instance, glass or acrylic. Although only two luminous tubes 2,3 are shown in the drawing, it will of course be appreciated that it is possible to use, e.g., just one luminous tube or that, depending on the size of the display face, more

than two luminous tubes may be used, these also advantageously being placed in semi-circular recesses in the opposite plates 8, 9. The transparent plates 8, 9 are provided with grooves which are indicated by means of the reference numerals 10 and 11 respectively. On the side facing away from the grooved face thereof, the plates 8, 9 may be wholly or partly covered by a light diffuser coating or a diffuser plate 12, 13 and 14, 15. An additional translucent or coloured plate 16 of plastic or glass may be placed adjacent to the plate 9 and the diffuser coatings or plates 14, 15 so as to be capable of bearing a text or the like that is to be displayed. Thus, by means of the arrangement in Fig. 5 an illuminated sign or an illuminated panel with the possibility of two-sided display is provided.

In Fig. 2 the arrows 17 indicate primary light ray input direction, whilst the arrows 18 indicate secondary light ray input direction. Like the embodiment in Fig. 1, this embodiment also has two light distribution plates 19, 20 that are provided with respective sets of grooves 21 and 22 on one side of the plates 19, 20. As shown in Fig. 1, the two plates are positioned in such manner that the grooved sides of the plates face each other. To prevent light in one of the plates 19 being scattered to the other plate 20, a light reflector plate or sheet 23 is expediently placed between the plates 19, 20. The sheet or plate 23 may, e.g., be an opaque, preferably white, plate or a plate provided with a reflective coating. A light diffusing plate or a display film, indicated in Fig. 2 by means of the reference numerals 24 and 25 respectively, can be brought to rest against the non-grooved sides of the plates 19, 20.
In the embodiment of Fig. 2 an illuminated sign or panel with the possibility of two-sided display is also obtained.

Fig. 3 shows a light distribution plate 26 that, in the same way as in the preceding embodiments, is provided with parallel grooves 27 on one of the sides of the plate 26. Light is introduced towards the plate 26 in the direction of the arrow 28 and/or 29. A light reflector plate or sheet 30 is placed adjacent to the grooved side of the plate 26. A light diffuser plate or display film 31 may be placed on the non-grooved side of the light distribution plate (the other side of the plate). If a light diffuser plate is used as a cover, this may optionally in addition be covered wholly or partly by a decoration, text, display film or the like (not shown in Fig. 3). In order to provide a best possible light distribution from a light source into the light distribution plate, where the light enters from one or both sides of the light distribution plate as indicated by means of the arrows 32, 33 in Fig. 4, where the light enters the light distribution plate 34 in the longitudinal direction of the grooves 35, it will be advantageous to allow the grooves 35 to have their

termination a short distance Δ1 and Δ2 from respective end edges 34', 34'' of the light distribution plate or the light distribution plates.

Fig. 5 is a schematic illustration of an illuminated sign or panel 36 where the direction of the grooves in the light distribution plate is indicated by means of the reference numeral 37. In connection with the sign or panel 36, a light source device 38 may be provided at one end thereof; in this connection see also Fig. 6. Alternatively, an additional light source device 39 (indicated in broken lines in Fig. 5) may be provided at the opposite end edge of the sign or panel 36. PWR indicates power supply to the light source devices 38, 39.

Figs. 7 and 8 show the third embodiment as indicated in Fig. 3, where the reference numeral 31 denotes a light diffuser plate, whilst the reference numeral 31' in Fig. 8 denotes a display film which typically may replace the light diffuser plate. As a further alternative, it is possible to treat the non-grooved side of the light distribution plate so that it has a frosted appearance. However, this requires an extra and unnecessary operation.

Fig. 9 shows a light distribution plate 40 which has grooves 41 and a light diffuser plate 42. In this solution, the light reflector plate or sheet 30, as indicated in Figs. 3, 7 and 8, has not been included.

Fig. 10 shows in cross-section the embodiment in Fig. 2. It will be seen that the grooves 21 in the first light distribution plate 19 are parallel to and immediately above the grooves 22 in the second light distribution plate. By means of the modification shown in Fig. 11, the grooves 21 in the first light distribution plate 19 are parallel with but laterally offset relative to the grooves 22' in the second light distribution plate 20'.

In the embodiment shown in Fig. 11, the light diffuser plate which should have been placed adjacent to the plate 20' may be omitted or, e.g., replaced by a display film 25' as indicated by means of broken lines. It is also possible to replace the display film 25' with a light reflecting coating or a light reflecting plate, in order thereby to increase the light output through the plate or the film 24.

In Fig. 12 grooves in the light distribution plate 44 are indicated by means of the reference numeral 43. A plate of opal material (e.g., acrylic or glass) that is coloured throughout or translucent is indicated by means of the reference numeral 45. The

centre-to-centre distance of the grooves is indicated by d1 and the thickness of the light distribution plate is indicated by d2. The opal plate 45 may, e.g., be 2 mm thick, although this should by no means be seen as a limitation. The opal plate may thus be thinner or thicker, or optionally be replaced by a display film. However, it will be appreciated that the opal plate by means of its thickness helps to ensure maximum uniform light on the free surface of the opal plate 45. The light which is typically scattered from a groove will have a scatter angle that is in the range of about 60-80°, preferably about 70°. When the light strikes the non-grooved side of the plate 44, it will be diffracted there. Owing to the light diffraction both in the boundary layer between the plates 44 and 45 and in the surface of the plate 45, the light intensity above the free surface of the plate 45 will emerge as almost uniform. The groove distance d1 will vary according to the thickness of the clear, light distributing, grooved light distribution plate 44. A typical formula for the groove distance is $d1 = d2 + k^* d3$, wherein d1 is the groove distance, d2 a fixed minimum groove distance, d3 is the thickness of the light distribution plate and k is a constant. According to one particular embodiment, the value of k can be 0.625 and d3 can be 1.5 mm.

Preferably the grooves have a greatest transverse dimension (width and/or depth) in the range of 0.3 - 2.5 mm, preferably in the range 0.4 - 0.8 mm.

To be able to provide grooves in the light distribution plate of plastic or glass, it is preferable to use a scoring tool or a so-called "scratcher" which may have a nose radius in the range of 0.4 mm - 2.5 mm, preferably 0.4 mm - 0.8 mm. It may be especially favourable to increase the nose radius of the "scratcher" when the thickness d3 of the light distribution plate exceeds 10 mm.

Although a "scratcher" can be used to provide the grooves, it is possible to use, e.g., a laser or a milling tool as an alternative. In view of the fact that the greatest transverse dimension of the grooves is relatively small, the use of so-called "scratchers" is at present most preferable for producing the grooves, wherein a plurality of laterally disposed "scratchers" can be used to produce all the grooves on a plate simultaneously.

Figs. 13-18 show typical light distribution patterns for different types of embodiments and different types of light sources and the number thereof, and also groove distance.

In Figs. 13-18 LI denotes light intensity and L denotes the length of the sign or panel. CCT and FT denote cold cathode tube and fluorescent tube respectively. In Figs. 13-16

1LS denotes a light source located on the left of the figure, like the light source 38 in Figs. 5 and 6, whilst 2LS denotes two light sources, like the light sources 38 and 39 in Figs. 5 and 6. Figs. 17 and 18 show the use of two light sources, but make use of either a single set of grooves (SSG) having a groove distance of 9.0 mm or a double set of grooves (having a groove distance of 4.5 mm).

All the embodiments make use of two light distributing plates which in the chosen example have a thickness of 12 mm, and where the opal plate which is on the non-grooved side of the light distribution plate has a thickness of 2 mm. The light reflecting material placed against the grooved side of the light distributing plate was, according to the test shown in Figs. 13-18, of the type 3M-Silverlux. To produce the grooves an 0.8 mm scratcher was used.

In Fig. 13 it will be seen that the use of two light sources gives quite an even light distribution when using cold cathode tubes, whilst the use of one light source (cold cathode tube) gives a slightly decreasing light output in the direction away from the light input edge of the sign or panel.

The drop in light intensity is more pronounced when using fluorescent tubes, as shown in Fig. 14. In this case where a double set of grooves is used having, e.g., a distance between them of 4.5 mm and a cut of 0.8 mm, as shown in Figs. 15 and 16, it will be seen that the light distribution for a cold cathode tube is approximately the same as for a fluorescent tube shown in Fig. 14. When using fluorescent tubes, as shown in Fig. 16, the changes in light intensity are considerably more pronounced.

Fig. 17 shows a comparison of Fig. 13 and Fig. 15 when using two light source devices in the form of cold cathode tubes, whilst Fig. 18 shows a comparison of Figs. 14 and 16 when using two light source devices in the form of fluorescent tubes. It will thus be seen that a uniform light distribution is achieved with a single set of grooves and the use of cold cathode tubes, as shown in Fig. 17 and indicated by means of the reference SSG. The use of double grooves (groove distance 4.5 mm) as indicated by DSG in Fig. 17 gives slightly less uniform light distribution.

The disclosed dimensions and the specific use of a particular reflector material in connection with the test example shown in Figs. 13-18 should by no means be viewed as defining the limits of the present invention, and should merely serve as an illustration of different possible variants of the invention.

Figs. 19, 20 and 21 indicate that the width and/or depth of the grooves may increase in the direction away from the light source device. When two light source devices are used, the width and/or depth of the grooves, seen in the direction from each light source device may increase until about the midway point between the light source devices. As indicated in Fig. 19, it is possible that the width and/or depth of the grooves does not increase linearly. The width and/or depth of the grooves will be able to contribute to the increase of luminous efficacy, where this according to Figs. 13-18 is lowest. As indicated above, the light source devices may be, e.g., cold cathode tubes, fluorescent tubes or another type of luminous tube.

As an alternative, the light source device may consist of a plurality of light-emitting diodes 46 which are placed side by side and arranged to beam in substantially the same direction, i.e., in the longitudinal direction of the grooves 47, as indicated in Fig. 22, where the light distribution plate is indicated by means of the reference numeral 48. The light-emitting diodes receive power supply from a power source indicated by the letters PWR via wiring 49. Advantageously, the heads of the light-emitting diodes 46 are arranged in a common or respective recess in the end portion of the light distribution plate 48. In one particular embodiment of the arrangement, the number of light-emitting diodes can correspond approximately to the number of grooves in the light distribution plate.

Fig. 23 shows another alternative solution for a light source device consisting of a plurality of light-transmitting, optical fibres 51, which are supplied from a common light source 52. The optical fibres 51 have their output end arranged to beam substantially in the longitudinal direction of the grooves 53 in the light distributing plate 54. The output ends of the optical fibres may either rest against the end edge of the light distribution plate or be placed in a common or respective recess 55 in the end edge portion of the light distribution plate.

Although a number of exemplary embodiments are described in the above description and shown in the drawings, it will however be appreciated by the skilled person that changes of design in the arrangement can be made without thereby departing from the idea and scope of the invention as defined in the attached patent claims.